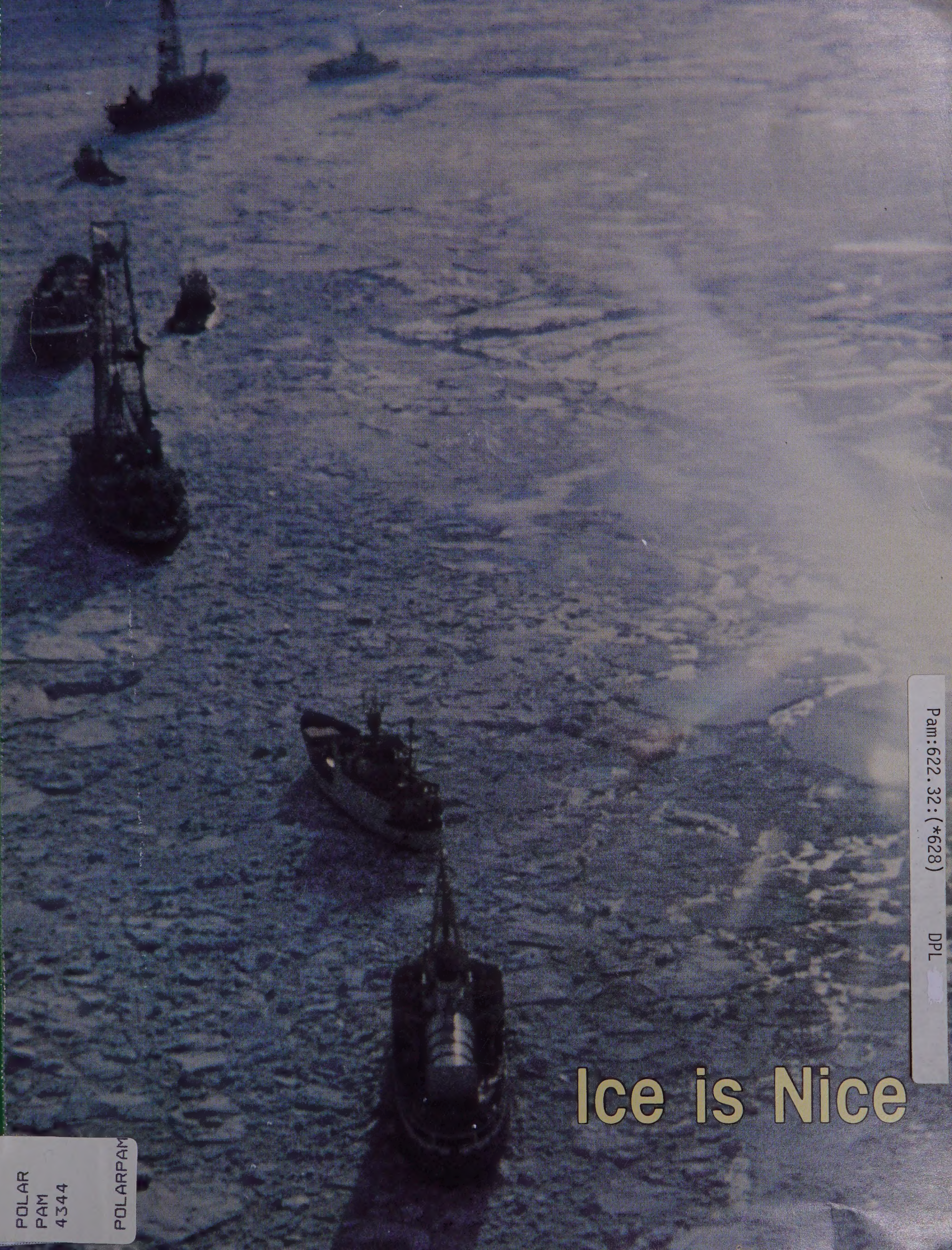


Ice is Nice

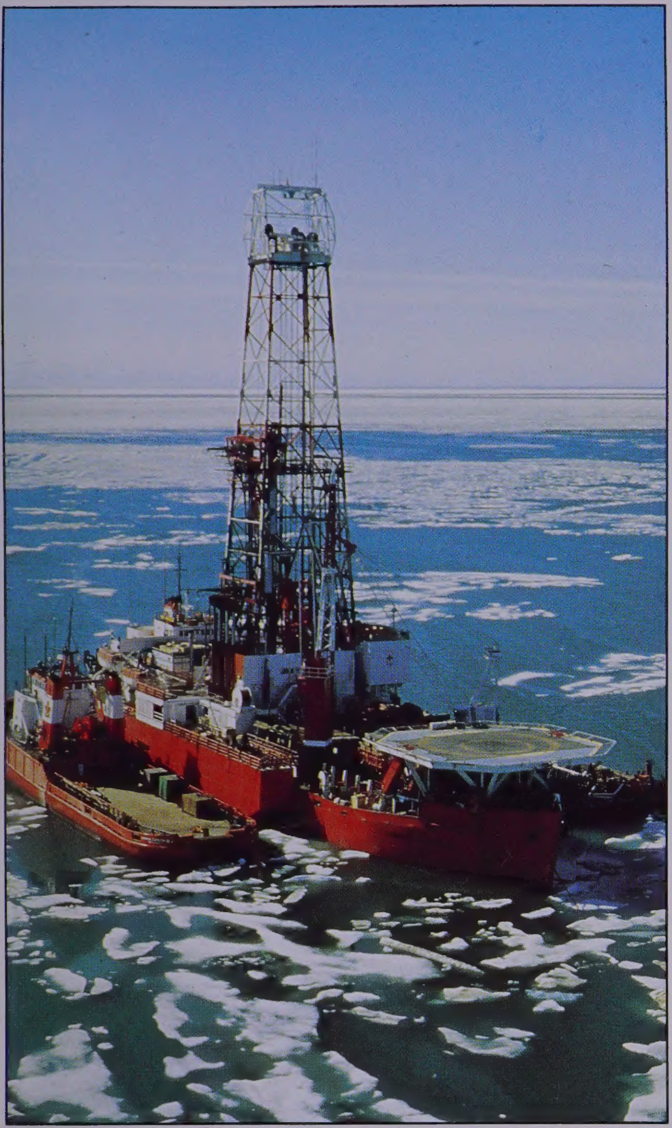
Oil Spill Research and Countermeasures for the Beaufort Sea

Contents

A convoy of drillships and icebreaking supply vessels in the Beaufort Sea (cover).

Oil spill containment boom being deployed across a bay during an open water shoreline training exercise (left).

Tuk Base, the hub of activity for Dome's offshore drilling operations, is located near the hamlet of Tuktoyaktuk. If a major spill response was required, the command post for the countermeasure operations would be headquartered at Tuk Base. The hamlet of Tuktoyaktuk is located on a peninsula reaching into the Beaufort Sea.



Drilling in the Beaufort Sea

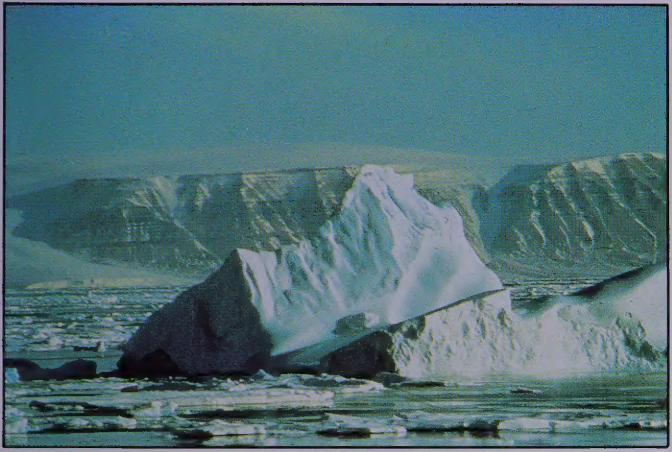
In the Northwest Territories, just east of where the MacKenzie River enters the Beaufort Sea lies the small Arctic community of Tuktoyaktuk. The nearby "Tuk" base — a hub of activity — is the base camp for Dome Petroleum's offshore drilling operations in the Beaufort Sea.

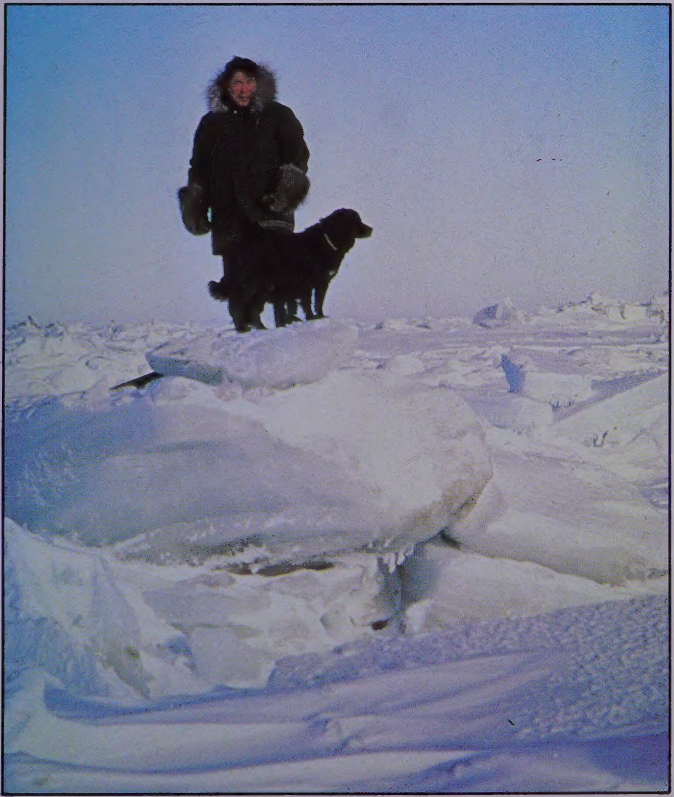
Dome and its partners have approximately 4.6 million hectares of oil and gas rights on the continental shelf of the Beaufort Sea. The sedimentary formations under these waters are believed to contain up to 7.5 billion cubic metres of recoverable oil — enough to supply Canadians with all their oil needs for at least the next 30 years!

To search for this oil, hundreds of millions of dollars have been spent over the last several years developing and operating drilling systems specially designed for the ice-infested environment of the Beaufort Sea. So far, 14 offshore wells have been drilled using a fleet of ice reinforced drillships owned and operated by the Company's subsidiary, Canadian Marine Drilling Ltd. (Canmar). Included in its fleet is the Kigoriak — a new generation ice-breaker and the first vessel able to operate year-round in the North American Arctic. With supply and drillships, work boats, dredges, barges, fixed-wing aircraft, helicopters and the large shore base at Tuk, the Company's total investment in Arctic drilling facilities exceeds $440 million.

Ice-reinforced drillships are supported on location by ice-breaking supply vessels. Large dredges are used to assist in the building of island drilling platforms known as artificial islands.

The arsenal of oil spill equipment is on 24 hour alert at Tuk Base. Training and exercise programs are conducted regularly to ensure rapid and efficient response by the Oil Spill Response Team. If required, the resources in the Beaufort Sea could be supplemented by additional industry and government resources.





The Major Concern

The Canadian public has always had a special attachment to the Arctic, and is naturally apprehensive about any activity there that might disturb the people or the environment. The major concern is that an oil well blowout might occur and cause tremendous damage. Dome shares this viewpoint and this has been reflected in its on-going activities in the Beaufort.

Fortunately, the chances of a major oil well blowout occuring during off-shore drilling operations are very slim. Specifically, of the thousands of exploratory wells drilled in off shore waters around the world, during the last 25 years, only one — the infamous Mexican blowout in 1979 — produced an oil spill.

Directed by rigorous government drilling regulations and regular inspections, Dome has spared no effort in developing environmentally safe systems since it began operations in the Beaufort Sea. The purpose of these systems is to prevent a major oil spill from occurring. However, despite the implementation of all the possible fail-safe systems it is still possible for a blowout to occur. Therefore, it is obviously prudent to be prepared to respond should this happen.

The essential components of a successful response to an oil well blowout would include:

1) appropriate contingency plans
2) sufficient logistical support
3) comprehensive training programs
4) technological capabilities.

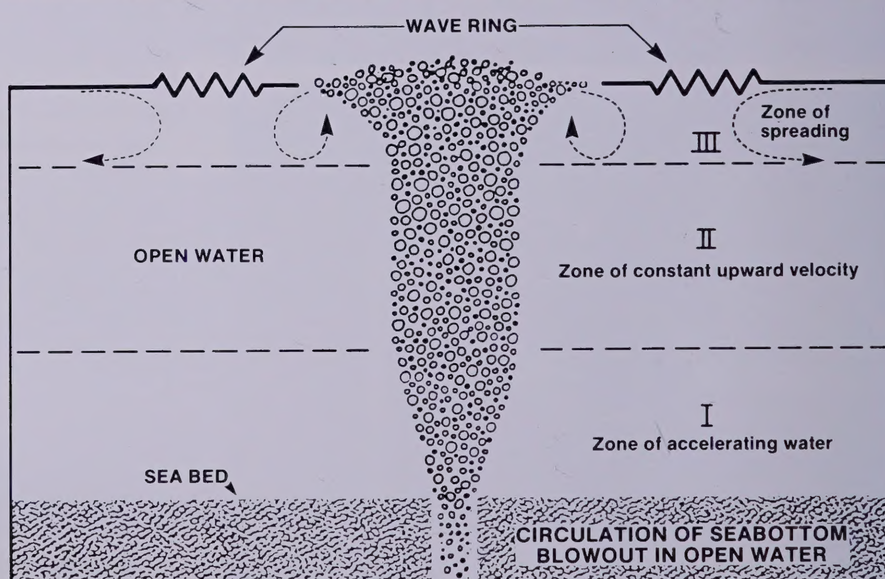
A contingency plan has been developed that brings together, in times of an emergency, all available resources from across Canada. All of Dome's resources would be supplemented by other industry resources, through existing cooperative arrangements, and government support through such agencies as the Canadian Coast Guard.

The experience and knowledge gained from six years of drilling in the Beaufort Sea has led to improvements in both the drilling program and the technology for oil spill clean-up. Field training programs and classroon simulation exercises are carried out regularly, just like fire-drills, to satisfy stringent government operating conditions and to provide each employee with decision-making experience in his particular area of responsibility. All of this has resulted in an enhanced capability to maintain the safety of the fragile Arctic environment.

Although the work done to date is considerable, there is always room for improvement; so, an extensive research and countermeasures program is conducted every year to develop new technologies and to upgrade the existing oil spill clean-up capabilities.

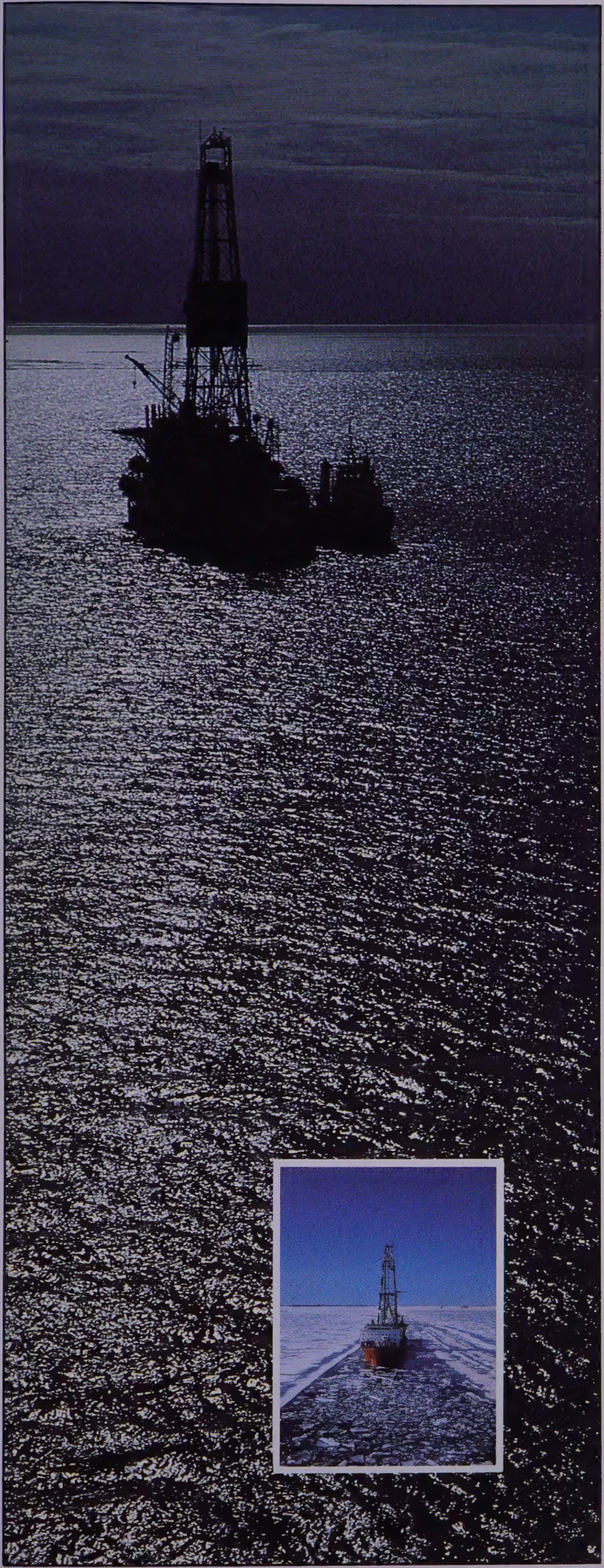
The purpose of the following pages is to describe these existing and future capabilities. First, let us briefly look at the problem itself: an oil blowout in the Southern Beaufort Sea.

The beauty and harshness of the Beaufort Sea region are depicted by an Inuit fishing vessel anchored in the calm waters of a bay, the constant movement of pack ice, and a hunter with his dog.



Courtesy, Fisheries & Oceans
Beaufort Sea project

The only sub-sea oil well blowout reported to date — the 1979 Mexican IXTOC 1 blowout — is shown in the above aerial photograph. An artist's rendering illustrates what a sub-sea oil well blowout would look like.



Blowout Behaviour in The Beaufort

Currently, Dome's Beaufort drilling operations take place during the 3-4 month period of summer when the area is mostly ice-free. If an oil and gas blowout were to occur during this period, it would look very similar to the Mexican Ixtoc I blowout that took place in the Gulf of Mexico in 1979. Oil would rise to the water's surface, partially burn in the fireball formed by the burning gas, and ultimately be swept from the area by currents and winds.

In summer, the Beaufort Sea is relatively calm. Compared to the more frequent year-round turbulence in the North Sea or Gulf of Mexico, the Beaufort has moderate waves (less than 1.5 metres most of the time) and gentle sea currents (generally under 1.4 kilometres per hour). Both these factors greatly assist oil spill clean-up.

However, for most of the year the Beaufort is frozen and the ice cover is virtually continuous. In winter, fractured ice thrusts both upwards and downwards under the forces exerted by colliding floes. Much of the ice is in constant motion, drifting with wind and currents, primarily in a westerly direction. This ice is influenced by the polar pack, a vast collection of thick ice floes, which move slowly and relentlessly in a clockwise circulation pattern north of the drilling zone.

If a blowout that occurred in summer did not seal itself or was not controlled by a relief well before the onset of winter, the well could run unchecked until the following spring. During the winter, the rising oil from the blowout would "paint" the underside of the moving ice sheets. If one assumes that winter lasts for 200 days and the average western movement of ice is 2.5 kilometres per day, then the result would be a painted strip of oil 500 kilometres long, approximately 160 metres wide, containing a few hundred thousand metric tonnes of oil.

This prospect is not as frightening as it might at first seem. After many years of research by both government and industry, it has been determined that *ice is nice* insofar as oil spill control is concerned. Ice provides a natural containment barrier for the oil and prevents it from spreading to vulnerable shorelines. Because ice grows downward, oil that spreads under the ice becomes sandwiched between the layers of ice and depending on the time of year, is encapsulated very quickly — in as little as 12 hours.

Oil which is trapped and preserved in ice all winter stays fresh and is therefore easy to burn off. About a month before spring breakup, the oil rises to the surface through two processes. Oil deposited under thin ice, early in winter, is exposed through ablation (when ice melts down to the oil). Oil deposited under thicker ice, later in winter, is mostly exposed through migration — a process whereby oil seeps upward through small holes in the ice made by salt concentrations. Once on the ice surface, the oil collects in pools thick enough to burn. Field tests have shown much of the oil can be burned directly on the ice, using air deployable igniters. More on this later.

A drillship heading for location during spring break-up (inset) and drilling during the open water season.

The first line of defense – in situ burning of oil and gas at the water's surface.

The response barge, shown in action during a recent exercise, is the second line of defense. This barge is the only one of its kind specifically designed for Arctic oil spill clean-up.

Summer Open Water Clean-up

The main priority of the oil spill contingency plan, for the Beaufort Sea, is to protect the areas which Northerners use and where birds, fish, whales and other important wildlife can be found. To this end, there is in place a three-tiered system for handling an oil well blowout, if one were to occur during exploratory drilling in the summer open water months.

The first line of defense is to burn the oil on the water surface above the blowout. Water currents from the rising gas bubbles create a natural containment ring for the oil, which tends to concentrate within the wave-ring around the blowout plume.

For oil that is not contained and burned within the wave-ring, the second line of defense would be put into action. This consists of a boom to contain the oil, a skimmer to recover it and a burning system to dispose of it. The entire system of equipment is mounted on the Response Barge which is stationed at Tuk base. If a major spill did occur at a drillship, the barge could be at the spill site in less than 24 hours and the entire system could be deployed and operational in less than an hour. Given the generally calm conditions of the Beaufort, the boom, skimmer and burner would be effective at least 90% of the time.

The Arctic boom is specially designed for offshore use in the Beaufort Sea. With solid flotation and a deep underwater skirt, this 1.5 metre high boom will contain oil in a stormy sea. Made of reinforced conveyor belting material, the boom can even withstand some contact with floating ice chunks.

When the boom is deployed in a V-configuration, it can funnel the contained oil to the forward end of the barge. To remove the floating oil, a Lockheed Skimmer with rotary blades and wipers has been used. This skimmer has been modifed by the addition of a new ice-processing pump, an enlarged oil recovery area and other changes for Arctic conditions. At the present time, a new concept Arctic Skimmer with more efficient pick up capability in partially ice-covered waters, at sub-zero temperatures, is being investigated. When proven, it will be added to the equipment arsenal for the Beaufort.

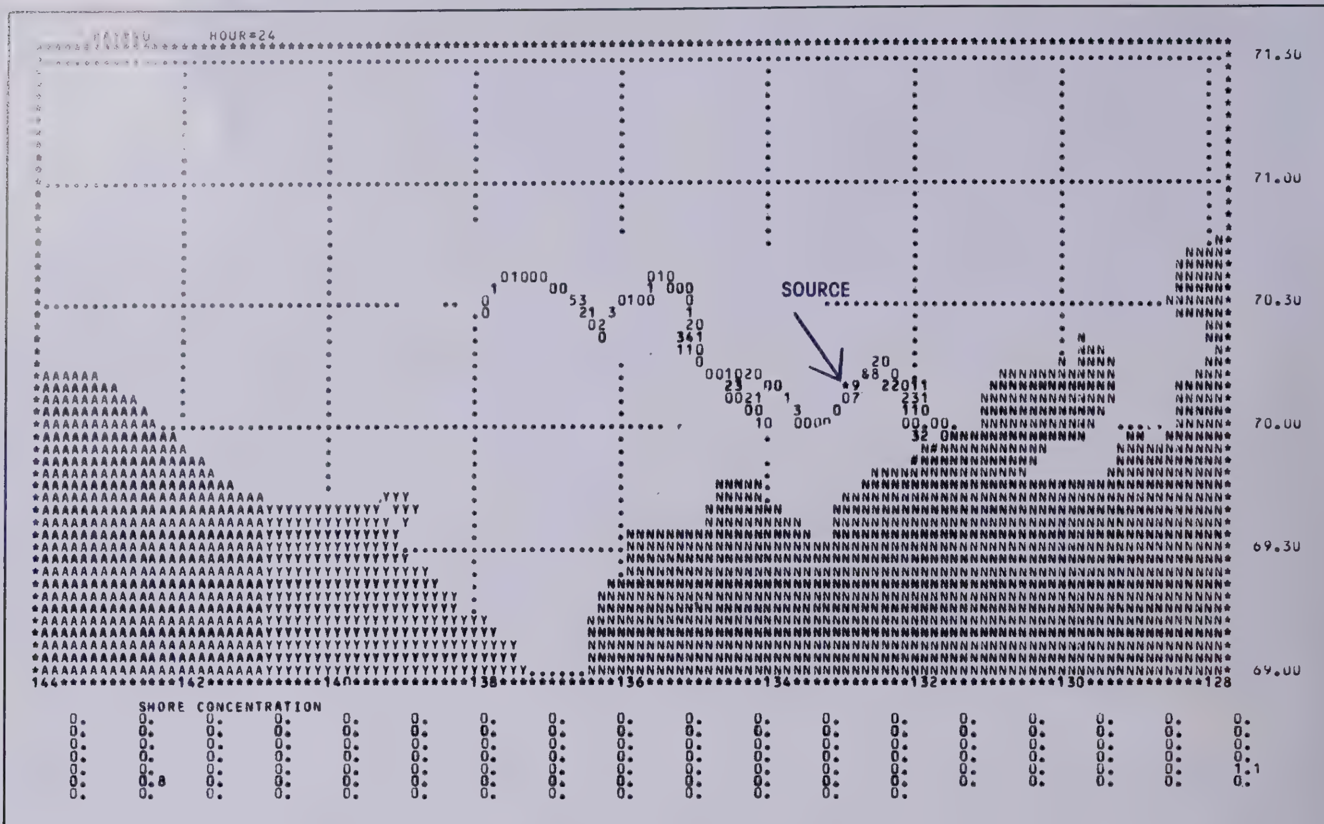
To dispose of the recovered oil, a burner is mounted on the Response Barge. The recovered oil can be burned off at a rate of up to 800 cubic metres per day.

The third line of defense, chemical dispersants, would be used as a last resort only if wildlife and other resources are in jeopardy. These chemicals, like dishwater detergents, break down the oil slicks into small oil droplets which then disperse into the water. However, as the relative effectiveness of dispersants in cold water is still under investigation, Dome does not at this time rely heavily on their use as a countermeasure for an Arctic oil spill.

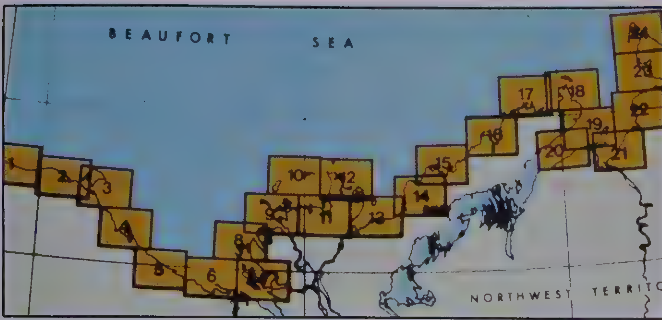
Through these three lines of defense, every effort possible is made to prevent an oil slick from reaching the shoreline. However, should an oil slick threaten Arctic shores, then the contingency plan for shoreline protection and clean-up would be initiated.

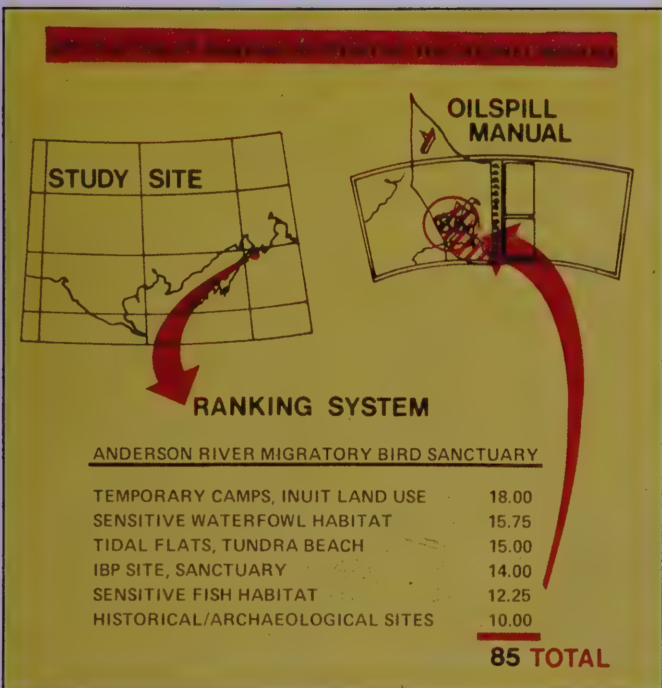
The plan of action for dealing with oil near the shoreline involves a four-step process. *First,* the probable path of the oil slick is predicted, so it can be dealt with before it reaches the shoreline. *Second,* critical areas are quickly identified for immediate protection. *Third,* prevention and clean-up equipment are deployed to protect the shoreline, while skimmers and burners are used to recover and dispose of the oil. *Finally,* birds and other animals are kept away from the area with various types of deterrent devices.

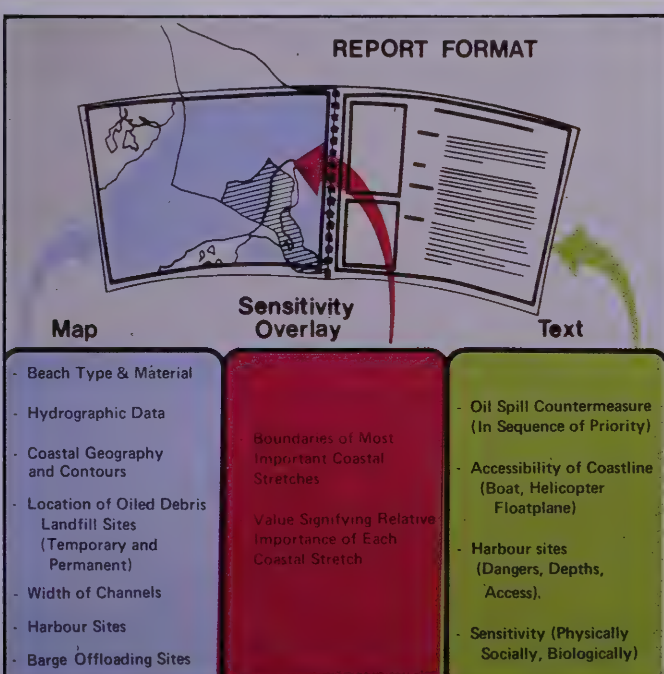
The third line of defense — aerial and vessel application of dispersants.



The computer print-out is of a hypothetical oil slick that has originated from a well blowout in the Beaufort Sea. The offshore movement of the slick over a number of days and its potential areas of beaching are illustrated.







Tracking the Oil

If an oil spill were to occur on the open sea, it would be immediately detected and tracked. It would be observed from ships and aircraft, while radio-tracked buoys would be deployed to trace the slick's movement and relay the pattern by telex or computer.

A computer tracking program has been developed for the Beaufort Sea which can predict the movement and fate of an oil slick. The computer converts weather forecasts into a map of the slick's movement over the next 48-hour period. Using recorded weather and wind data, the computer generates an inventory of possible drift patterns. The model determines which shoreline areas might be hit, how long it will take before contact and how much oil can be expected to be washed ashore.

Identifying Shoreline Areas at Risk

Once the oil is tracked, the on-scene commander would turn to the *Beaufort Sea Atlas* and the *Shoreline Protection and Clean-up Manual.* These provide all the necessary information for quick and well-informed decisions in an emergency.

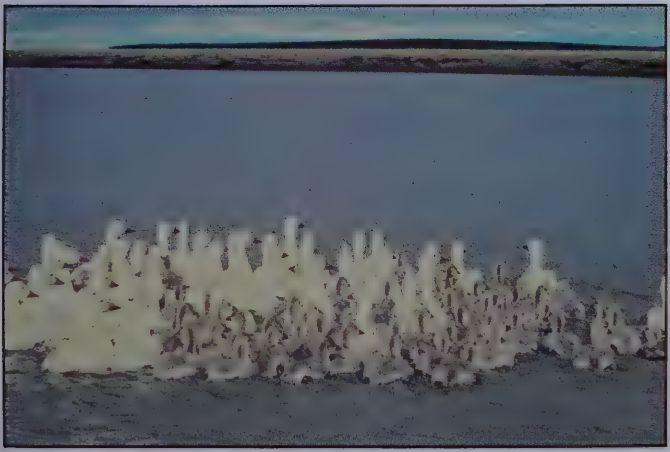
When Dome began drilling in the Beaufort in 1976, it initiated a study of sensitive areas requiring protection from an oil spill. An atlas of the coastal area was prepared from extensive research, interviews and shoreline reconnaissance. Aerial photographs were taken of the entire shoreline from the Alaskan border to Baillie Island. The resulting *Beaufort Sea Atlas* was produced. It contains hydrographic charts with overlays of key areas and photographs of representative regions.

To update and verify the information in the *Atlas,* an intensive field program over two years was conducted along the Beaufort coastline. From this fieldwork, the *Atlas* was expanded into a concise easy-to-use *Shoreline Protection and Cleanup Manual for the Southern Beaufort Sea.*

In this *Manual,* the coastal area along the 2,240 kilometres of shoreline was ranked according to its human, biological and geological sensitivity. This ranking allows the on-scene commander to quickly direct his attention to threatened areas with the highest ranking. For each location, the *Manual* also outlines clean-up strategies appropriate to each specific shoreline area. As a supplement to the *Manual,* the entire Beaufort Sea coastline has been videotaped to provide a library of additional information for the on-scene commander.

Shoreline areas requiring protection in times of a major spill are outlined in the "Shoreline Protection and Clean-Up Manual for the Beaufort Sea." This manual ranks shorelines according to human, biological and geological sensitivities.

The above sequence of photos illustrates shoreline countermeasure response in the Beaufort Sea. Boom is stretched across the bay, skimmers are deployed to pick up the oil and the portable burner disposes of the recovered oil.



Protecting the Shoreline

At Tuk, of the 10,000 metres of boom available, there are over 6,000 metres of shoreline boom. This boom would be placed across important bays, spits and lagoons to prevent the oil from reaching the shore. Compared to the heavier offshore boom which must withstand high waves, the near-shore boom is compact and lightweight. It can be quickly transported and rapidly deployed at the scene of a spill.

In shallow bay exercises, various lengths of near-shore boom (up to 730 metres) have been placed from one end of the bay to the other in less than 15 minutes. The contained oil is then skimmed and flared off with a portable burner.

A Rotary Cup Burner, which can be carried to an oil spill site by helicopter, has been developed and tested. The burner will handle water-in-oil emulsions that are as much as 60% water by volume. It can flare off 80 cubic metres of oil a day, depending on the amount of water in the emulsion. This means that an oil slick 8 hectares in area and one millimetre thick can be completely disposed of in 24 hours.

The burner was developed over a three-year period. The behaviour of Arctic oil emulsions was studied in the laboratory to determine the basic requirements for the burner. As a result of these studies, a burner was designed and tested. After modifications, the burner was shipped North for field tests at Tuk. Over a five-month period, in the summer of 1981, the portable burner was successfully field tested. During this period of time it was used to dispose of approximately 3600 cubic metres of waste oil that had been accumulated over the previous five seasons of Northern operations.

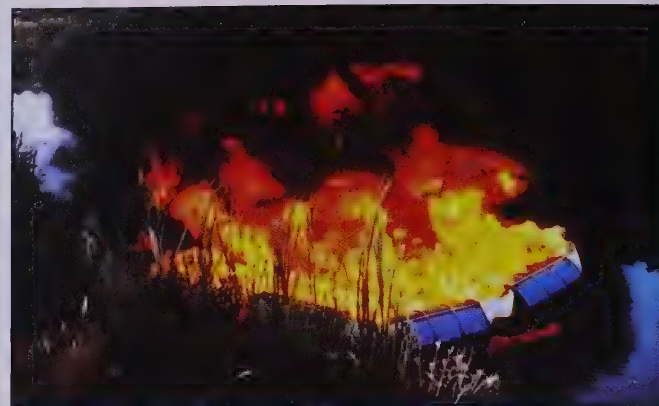
The portable burner is now a successful piece of oil disposal equipment for oil spill countermeasures in the Arctic.

Protecting Birds and Wildlife

While the oil is being contained by near-shore booms, various deterrent devices would be used to keep waterfowl and other animals from landing on a spill site. Field work has been done with deterrents like bird-scare cannons, electronic bird alarms and helicopters. Even ultra-sonic methods have been investigated. Vision-based deterrents such as dyes for colouring the spilled oil and coloured objects have also been evaluated.

The results of these studies and tests so far indicate, surprisingly, that helicopters and human activity are probably the most effective bird deterrents available. Bird-scare cannons were also found to work well over short periods of time.

The Beaufort Sea area harbours a variety of wildlife species which include seals, polar bears and geese.



The original concept for the fireproof boom consisted of oil drums joined together by fireproof material. The second generation fire proof boom, a stainless steel model, is shown during initial towing and test tank trials.

New Developments

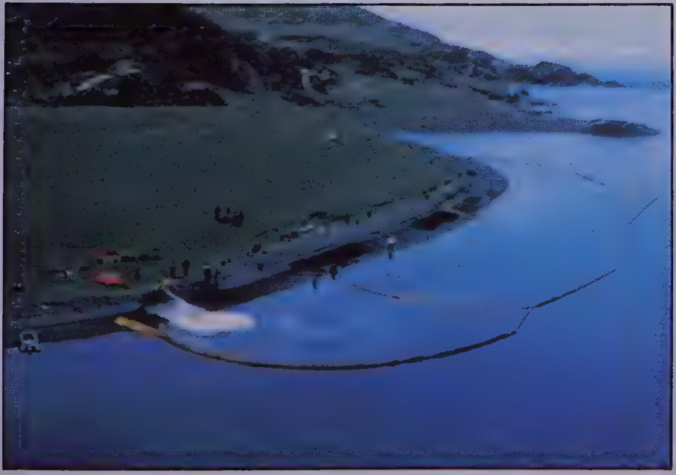
Fireproof Boom

New approaches to Arctic oil spill recovery are continuing to be investigated. One result has been the development of a fireproof boom. This boom contains and concentrates oil so that it is thick enough to burn while still on the water's surface. It can sustain flames and intense heat and has been designed to contain oil in waves equivalent to some of the roughest sea states in the Beaufort Sea.

Over one-half million dollars has been spent in the past three years to design and test this stainless steel boom. The first attempt at a fireproof boom, the "quickie" boom, was built with six oil drums and a heat resistant connector. After this, a more durable boom was constructed of stainless steel floats connected by a non-flammable accordion-pleated section.

The boom was first tested in waters off British Columbia for its ability to stay in tow and withstand the heat of burning oil. It was then taken to a test tank of the U.S. Environmental Protection Agency in New Jersey. Here, the boom was tested for its ability to contain, thicken and burn oil in simulated waves and currents. In the tank, the boom proved it could contain and burn oil in waves equivalent to 1 to 1.5 metres and winds of approximately 35 kilometres per hour — typical Beaufort offshore storm conditions.

The final step in this development program will require that the boom undergo a rigorous field testing program in the offshore waters of Canada. Only after successful completion of these offshore trials, will the fireproof boom be added to the stockpile of oil spill equipment in the Beaufort Sea.



Sub-Sea Containment

Another concept that is being investigated involves the use of a sub-sea containment technique. This concept could be used not only during the open water's season but also throughout the winter in the Beaufort. Oil and gas released from a sub-sea blowout would be funneled through large, flexible hoses to a floating containment ring at the water's surface. The oil and gas would then be burned off within the ring. Preliminary work on this concept is well under way and field trials will soon be undertaken.

Reciprocating Kiln

A portable kiln is being modified to remove spilled oil from beach sand. The design is based on a rotary kiln which was used successfully in a Nova Scotia spill involving the tanker Kurdistan. Oil soaked sand is shovelled into one end of the kiln. The sand is heated and tumbled to burn off the oil, leaving clean sand that can be replaced on the beach. Blueprints for the three-piece portable kiln have been prepared and the kiln is ready to be constructed and tested for Arctic conditions.

Portable Debris Incinerator

To complement the reciprocating kiln, research is being carried out on an air transportable incinerator which will be able to dispose of oil-contaminated debris at the rate of approximately 1 tonne per hour. It is anticipated that this incinerator will be ready for field testing in the Beaufort, during the summer of 1982.

Dispersants

Investigations are continuing on the use of dispersants for shoreline clean-up. Much of the work is being done cooperatively through the BIOS (Baffin Island Oil Spill) Project. This is a $6 million government and industry program which is studying, in part, the effects of using dispersants under Arctic conditions. Through this project, the impact of treated and untreated oil on the near-shore environment and the use of dispersants for shoreline protection and clean-up will be more clearly known.

An artist's rendering depicts the sub-sea containment concept presently under investigation. The use of dispersants as an oil spill countermeasure in near-shore areas is being investigated through the BIOS project.

Oil coming to the surface in open water leads or ice cracks can be successfully ignited and burned on the water's surface

Fall Freeze-up and Winter Ice

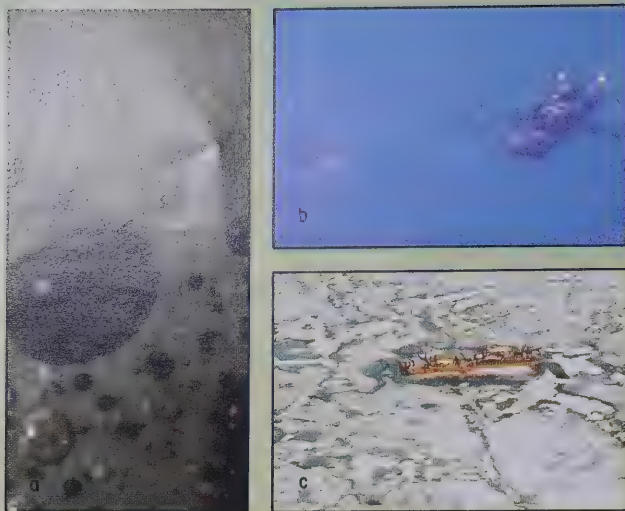
If an oil well blowout in the Beaufort Sea were to occur during freeze-up in the fall and continue through the winter months, the main clean-up would take place during the spring.

During the winter months, the oil deposited under the moving ice would be tracked by placing marker buoys periodically on the ice, near the blowout site. These buoys would relay their position by satellite, on a daily basis, enabling the oil to be tracked by following the ice movement.

Any oil spotted on the ice surface or in open water leads would be ignited and burned *in situ*. A research study has been recently completed which demonstrated that crude oil can be ignited and burned in ice cracks at temperatures down to −35° Celcius and in wind speeds in excess of 35 kilometres per hour.

Important research is being conducted on various systems for the mechanical recovery of oil under and within ice during winter and freeze-up conditions. One such system, the sub-sea containment technique, was previously discussed under new developments for the open water situation. Another system being considered is an under-ice oil vacuum cleaner. Other concepts being investigated would make use of the ice-breaker, the Kigoriak, as well as the dredges stationed in the Beaufort Sea.

Satellite tracking buoys, such as the Argos buoy, are used in the Arctic to track ice movement. The Kigoriak, a new generation icebreaker, is the first vessel to operate year round in the North American Arctic and would be used to support a spill response conducted during the winter. This vessel will soon be joined by Dome's new icebreaker, the Robert LeMeur.



During the oil and gas under sea ice experiment, oil discharged under winter ice was quickly encapsulated in the form of droplets (a). The aerial photos are of the test site taken prior to (b) and during spring break-up (c). During this period of time, oil that appeared on the ice surface was disposed of through in situ burning.

Spring Breakup - In Situ Burning

The main clean-up of unburned oil from a well blowout at the end of the drilling season would take place in the spring. As already mentioned, in a blowout, oil is released to the surface, until a relief well is drilled or the well seals itself. However, if the flow does not stop during the same season, the oil remains encapsulated in the ice throughout the winter. In the springtime, the oil rises to the surface, collects in pools, and can then be disposed of through *in situ* burning.

Observing Oil and Gas Under Ice

Industry has recently completed a major study that investigated the fate and behaviour of oil, released in the presence of gas, from a sub-sea blowout under first-year ice.

An experimental spill in 1975 in the Northwest Territories showed that oil, *without gas,* is easily burned off when it rises to the ice surface in the spring. Later laboratory work studied the effects of gas on the spread of oil under ice.

The most recent project was undertaken to test in the field how easily oil, *with gas,* that rises to the ice surface can be ignited. The project also investigated the optimum time to use igniters and what type of igniters worked the best.

The results of the field trials proved highly encouraging for reducing the effects of a sub-sea blowout. The oil rose to the ice surface in the spring and accumulated in pools thick enough to burn. Some 80% of the discharged oil was totally removed from the marine environment. The remaining 20% dispersed naturally into the offshore waters.

The experiment took place in three phases over eight months, from December 1979 through July 1980. In the first phase, approximately 6 cubic metres of oil with gas were discharged under the ice. During the second phase (5 months later), two more discharges took place comparing the effects of the time of discharge on oil rising to the surface. In the final phase, the appearance of oil on the surface was monitored and recorded.

Daily readings of oil temperature, volume, area and thickness were taken. Oil samples were collected for analysis. The pools were studied with radar surveys and regular aerial photographs. A film recorded the test-burning by igniters.

The experiment revealed a number of significant facts. Most of the oil formed large droplets which clung to the under surface of the ice within a 50 metre radius of the blowout plume. During spring, 85% of the oil appeared on the surface, either by the ice melting or the oil migrating through brine channels, before the ice sheet completely rotted. Because the oil did not weather while encapsulated in the winter ice, it was easily burned off using igniters deployed from a helicopter.

Oil deposited under sea ice rises to the ice surface in the spring by two competing processes — ice ablation (top) and brine channel migration (bottom).

During an experiment conducted near Yellowknife, igniters were deployed from a helicopter onto pools of oil. Successful ignition resulted in the in situ disposal of approximately 95% of the oil contained in the melt pools.

Air Deployable Igniters

Large scale burning over a wide area with many thousands of oil pools, requires igniters which can be dropped from helicopters.

Igniters are a versatile countermeasure which can be used year-round for different types of applications. In spring, they will ignite oil collected in pools on the ice surface. In fall or winter, they will ignite oil between or on ice floes. In summer, they can ignite oil contained on the open seas within a fireproof boom.

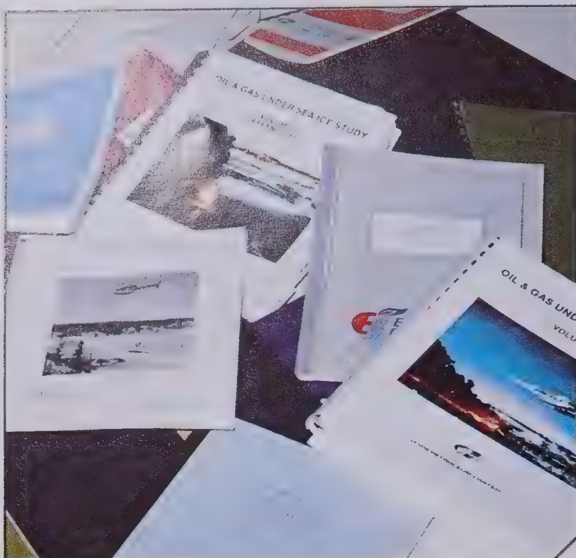
The first step in developing a suitable igniter was to select the most efficient ignition fuels. The chemicals chosen were "solid propellant" (or rocket fuel) to preheat the oil, and gelled kerosene (solid barbecue lighter) to burn 5 to 10 minutes until the oil slick became self-fuelling.

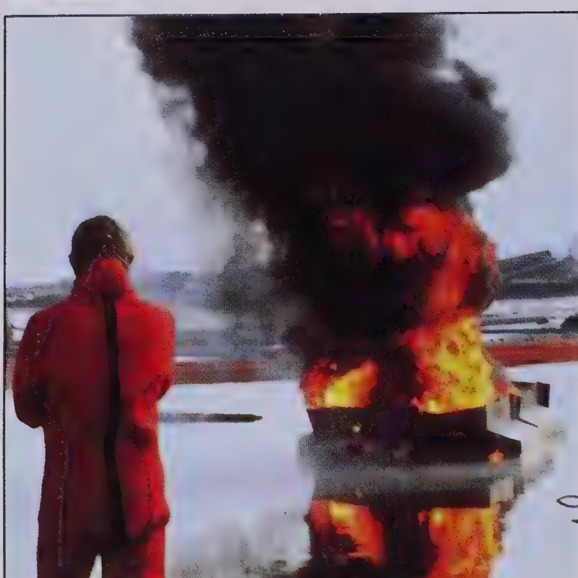
The initial design of the air deployable igniter consisted of the two different types of fuel sandwiched between steel grids and fired by a standard safety fuse. A block of wood on either side provided strength and buoyancy.

In the spring of 1978, the original air deployable igniter was tested in the Northwest Territories. Igniters were dropped from a stationary helicopter into pools of oil on ice. They successfully burned 95% of the oil. Further tests helped to develop the igniter to its present state where it is more durable, compact and efficient.

The redesigned igniter was tested in simulated field experiments in Ontario and given a final field test near Tuk base. When deployed from a helicopter flying at 5 kilometres an hour and at a 5 metre altitude, the igniters proved to be extremely effective in igniting oil in melt pools. Since then, minor modifications have been made to extend the storage life of the igniters.

The original design of the air deployable igniter (top). The air deployable igniter in its final form (bottom).


OIL & GAS UNDER SEA ICE STUDY



Conclusion

It is not intended to leave the impression that oil spill clean-up in the Beaufort Sea is easy or that there would be no environmental damage in the event of a major spill. Rather, the purpose is to demonstrate that during the past six years of operation in the Beaufort Sea much has been learned about the Arctic and that this knowledge has been incorporated in the oil spill countermeasures program. This has resulted in an enhanced oil spill clean-up capability in the Arctic.

Today in the Beaufort Sea, contingency plans are in place; extensive and complete logistical backup is available in the form of boats, planes, oil spill equipment and personnel; comprehensive training and exercise programs have been carried out; and technology is rapidly evolving – all these resources would significantly reduce the impact of an Arctic oil spill. Many of these plans, logistic capabilities, programs and techniques were not available and much of the technology was not even conceived when exploration first began offshore in the Beaufort Sea.

The concerns expressed by private individuals and organizations are being listened to. Much work has been done and more is being undertaken. Industry as a whole and on an individual basis is responding to the challenge of Arctic oil spills.

Laboratory and field research programs will continue to advance environmental protection in the Arctic.

Epilogue

In order to produce and transport crude oil from the Beaufort Sea, continued innovation in Arctic technology is required. The planning, engineering and testing of such systems, based on the successes of the last six years, is underway.

As with exploratory drilling, the primary environmental concern associated with production and transportation operations is a major oil spill. Through research and development, industry and government will continue to ensure that the systems for use in the Beaufort Sea are as spill-free as possible. Adapting proven oil spill countermeasures and developing new ones as required will ensure that one of the world's most successful oil spill countermeasures program continues.

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